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Higher Technological Education

One of the most important sections of the recently issued Report* of the Special Committee on Higher Technological Education set up by Mr. Butler when Minister of Education is that dealing with the need for new courses at the higher level in technical colleges involving substantial periods of continuous study. The Committee recommends, *inter alia*:—

"The selection of a strictly limited number of technical colleges in which there should be developed technological courses of a standard comparable with that of university degree courses. The selection of these colleges must be a matter for the Minister of Education; but we suggest that, for engineering, up to six colleges, exclusive of any in the Greater London area, might be selected in the first instance. While these technological courses would be a distinctive feature of such colleges, they would have many other activities. The conditions in any one college would obviously be adapted to suit local needs; but one would expect to find, in addition to the special higher technological courses, a large volume of part-time work of an advanced character for Higher National Certificates and other qualifications of similar standard. Further, a very important function of these colleges would be the provision of post-graduate courses in special branches of technology; these courses might be either full-time or part-time, and would be intended generally for their own graduates or for graduates from universities and for men who had been in industry for some time. We are of the opinion that far too little attention has been paid in the past to refresher courses and "new development" courses, both of which would come in this category. A college might also conduct as one of its activities a national school in a particular branch of technological study, such as plastics, rubber technology, foundry work or welding, in which the very highest grade of work for the whole country might be done. Finally, a college would probably have an important part to play in conducting investigations for local industry into specific problems. While large firms with well-equipped research departments would not normally require such assistance, it must not be forgotten that the majority of firms are small, with few facilities for the proper conduct of investigations and research. We would regard this service to industry as a very important function of these colleges."

Herein, then, is a definite recommendation from the highest authority for the rapid re-establishment of the British Foundry School. This is also enthusiastically supported by the Council of Ironfoundry Associations; the Institute of British Foundrymen; the Cast Iron Research Association —in fact, the whole of organised thought within the industry. Yet, apparently, the Board of Governors have reached an *impasse*. On the various education committees upon which we have the honour to serve, this question of the Foundry School appears with monotonous regularity upon the agendas. There is never anything really authoritative to report—only that some member has heard from some other committee the latest rumour. These have varied from an anticipated immediate action, to the holding of luncheon parties at which all interests would be present so that further consideration could be given to the subject. The latest rumour is that the school selected by the Governors is not available, as it has been requisitioned by one of the armed Services. We are well aware that there is an acute shortage of accommodation in the scholastic establishments of Great Britain, but until there is a report from the Governors that they have tried every potential establishment from Newcastle-upon-Tyne to Brighton we shall continue to express the obvious anxiety of the greater part of the foundry industry at the lack of progress made. As there are in being at the moment several committees within the industry which are anxious to help along the scheme, we deem it desirable that the Governors should report to those committees the progress they are making or the difficulties they are encountering. We personally cannot believe them to be insuperable.

(*Continued overleaf, col.* 2.)

*Price 6d. net from H.M. Stationery Office.

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FORTHCOMING EVENTS

(Secretaries are invited to send in notices of meetings, etc., for inclusion in this column.)

NOVEMBER 16.

Institution of Mechanical Engineers:—Thomas Hawksley lecture, "The Scientist in Wartime," by Sir Edward V. Appleton. At Storey's Gate, St. James's Park, London, S.W.1, at 5.30 p.m.

Keighley Association of Engineers:—"Industrial Automatic Control," by F. Blezzard. At Devonshire Buildings, Devonshire Street, Keighley, at 7.30 p.m.

Manchester Association of Engineers:—"Developments in Textile Finishing Machinery," by K. S. Laurie. At the Engineers' Club, Albert Square, Manchester, at 6.45 p.m.

NOVEMBER 19.

Sheffield Society of Engineers and Metallurgists:—"Aero Engines, 1915-1945—Some Personal Impressions," by Major G. P. Bulman. At the Royal Victoria Station Hotel, Sheffield, at 6.15 p.m.

NOVEMBER 21.

Institute of Welding (Wolverhampton branch):—"Electrical Technique in Resistance Welding," by T. E. Calverley. At the Victoria Hotel, Wolverhampton, at 7 p.m.

NOVEMBER 22.

Institute of Welding (South Wales branch):—"The Welding of Aluminium," by Dr. E. G. West. At Neath.

NOVEMBER 22 and 23.

Iron and Steel Institute:—Autumn general meeting at the Chartered Surveyor's Institution, 12, Great George Street, London, S.W.1.

NOVEMBER 23.

Institution of Mechanical Engineers:—"The Place of Women in Post-war Engineering," by Miss Verena Holmes. At Storey's Gate, St. James's Park, London, S.W.1, at 5.30 p.m.

NOVEMBER 24.

Institute of Welding (Sheffield branch):—Joint meeting with Doncaster Engineering Society. At the Technical College Hall, Doncaster, at 6.30 p.m.

Keighley Association of Engineers:—Visit to A. V. Roe & Company, Limited, Yeadon.

NOVEMBER 26.

Association of Bronze and Brass Founders:—Scottish area meeting. At the Grosvenor Restaurant, Glasgow, at 1 p.m.

NOVEMBER 29 and 30.

Institute of Vitreous Enamellers:—Annual meeting. (For details see our issue of October 18.)

Institute of British Foundrymen

NOVEMBER 17.

East Midlands branch:—"A New Method of Investigating the Behaviour of Charge Materials in an Ironfoundry Cupola and Some Results Obtained," by N. E. Rambush and G. B. Taylor. At the Technical College, Leicester, at 6 p.m.

Wales and Monmouth branch:—Visit to the Glanmor Foundry Company, Limited, Llanelly. "Gating and Feeding of Steel Castings," by S. T. Jazwinski, E. D. Wells, and S. L. Finch, at 2.30 p.m.

NOVEMBER 24.

Bristol branch:—"Duplex Pump Castings," by Brown and Dewhurst. At the Merchant Venturers' Technical College, Bristol, at 7 p.m.

Falkirk section:—"Enamelling and Protection Finishes for Cast Iron," by W. W. Shaw. At the Temperance Café, Lint Riggs, Falkirk, at 6 p.m.

NOVEMBER 26.

Sheffield branch:—"The Technological Principles of Casting Design," by Prof. V. M. Shestopal, presented by W. H. Salmon. At the Royal Victoria Hotel, Sheffield, at 7 p.m.

NOVEMBER 28.

Birmingham branch:—Short Papers on "Economical Quick Methods of Preparing Plate Patterns for Limited Quantity Production." At the James Watt Institute, Great Charles Street, Birmingham, at 7.30 p.m.

London branch:—"The Technological Principles of Casting Design," by Prof. V. M. Shestopal, presented by C. H. Kain. At the Charing Cross Hotel, London, W.C.2, at 7.30 p.m.

INFLUENCE OF SILICO-CALCIUM ON THE PROPERTIES OF GREY CAST IRON

The following is a *résumé* of the Belgian Exchange Paper to the recent French foundry congress. It was prepared by MM. Georges Delbart, André Thorel and René Bucquet. The first part of the Paper reviewed the work of Lemoine (Association Technique de Fonderie, September, 1936) and Piwowarski ("Giesserei," No. 27—1940), and then detailed some preliminary tests made by Etabs Cail, wherein quantities ranging from 0.5 to 12 per cent. of a 50:50 alloy of silicon and calcium were used. The following conclusions were established:—(1) Decarburation of the iron by the formation of calcium carbide in quantities equal to at least 2 per cent.; (2) reduction by 50 per cent. of the sulphur content; (3) phosphorus content practically unchanged, with a tendency to reduction; (4) slight variation in the mechanical properties of test-pieces taken from 40-mm. by 4-mm. bars. Amongst these properties, the deflection is most variable and is inclined to be reduced; and (5) the silicon yield is of a low order.

The final section deals with wall thickness sensitivity, and a comparison is made between the base irons and those receiving a ladle addition of 6 per cent. Si-Ca. It is possible to state that the Si-Ca additions, despite the increase in silicon content which they bring about, clearly reduce in a great many cases the heterogeneity of irons of diverse qualities. In samples of a thickness equal to or greater than 25 mm. the stepped test-pieces frequently show mechanical properties superior to the base iron—despite higher silicon content.

The curves included in the Paper, of which each point represents at least three or four tests, show a wide dispersal of results. However, there is observable a distinct irregularity in the effect of silico-calcium, especially as to its desulphurising and decarburising actions. This can be attributed to the more or less serious loss of the additions through being taken up by the slag or by oxidation.

Higher Technological Education

(*Continued from previous page.*)

If the Governors deem the obstacles so great as to be incapable of surmounting, then we suggest they hand over their responsibilities to the Institute of British Foundrymen, which body is specially charged by its Royal Charter to undertake the educational activities. As the two "industrial" members of the Government Special Committee—Sir George H. Nelson and Mr. FitzHerbert Wright—are both connected with the foundry industry, it is obvious that they will do everything within their power to implement the recommendations of the Report, and, on behalf of a waiting public, we ask them to use their great influence to overcome the present apparent *impasse*.

THE GATING AND FEEDING OF STEEL CASTINGS*

Higher yield of sound castings results from application of science to gating problems

By S. T. JAZWINSKI, Dpl.-Ing. Met. (Member), E. D. WELLS, Assoc.Met. (Member) and S. L. FINCH (Member)

Summary

The physics of feeding point out that there are five main factors which affect the feeding of castings. These are time, temperature, mass, analysis and pressure. The necessity of having a balanced system of feeding is illustrated. Directional solidification is discussed and the methods for promoting this are outlined briefly.

In the general description of gating and feeding, gravity, atmospheric and centrifugal pressure methods are compared. The supply of liquid steel from a feeder head is considered and the solidification of a gravity, whirlgate and atmospheric head studied.

The optimum proportions and shape of atmospheric whirlgate head and optimum neck size are determined by experiment. An economic comparison between gravity and atmospheric whirlgate heads is tabulated, showing the greatly increased yield and saving in manhours using the latter method. Proof is given that, although in limited cases graphite rods can equal the feeding efficiency obtained using the orthodox type of atmospheric head, the danger of carbon segregation will prevent this method being adopted on a production basis.

Introduction

Speaking generally, it is easy to produce a sound casting if the question of economy is disregarded. Experience shows that the average yield of steel castings (yield being the ratio expressed as a percentage of finished weight to rough weight, including runners and risers) varies from 50 to 60 per cent., except in the case of castings made by specialised processes such as centrifugal castings. This yield is one of the foundations of foundry costs. As the actual volume contraction of steel in the liquid state is approximately 4 to 6 per cent., varying with casting temperature, it is obvious that the actual amount of head metal supplied to a casting is greatly in excess of the amount theoretically required.

Between the two world wars, and especially during the present conflict, great advances have been made in the foundry industry consequent upon the increased use of mechanical equipment, better planning, development of new processes and the greater use of metallurgical control in sand preparation, heat-treatment and steelmaking. Greater general efficiency has resulted, but only in exceptional cases has there been improvement in yield of castings.

Following the development of the whirlgate head in this country by Hopkinsons, Limited, there came the discovery made by Williams, and developed by Taylor and Rominski, of the utilisation of atmospheric pressure in the feeding of castings. Thus it may be said that applied physics became a matter of serious study for the foundryman. The most recent advance is the prolonging of the active life of a feeder head by taking into consideration the upper portion of the iron-carbon equilibrium diagram, and the effect of graphite solution in the upper regions of a feeder head. It may be that, in the near future, the upper part of the iron-carbon equilibrium diagram may be as useful to the foundryman and metallurgist as the lower portion is to the metallurgist in the determination of correct heat-treatment.

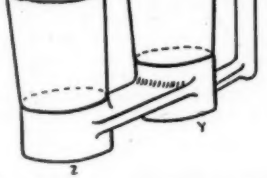

FIG. 1.—AN EXAMPLE OF A GRAVITY-FED CASTING.

Progressive foundrymen have attempted to apply these fundamental laws, but under the existing conditions which have been determined by years of tradition and prejudice. Unfortunately, in many cases these new theories have met with failure due to lack of understanding of the fact that no single design of feeding can possibly prove efficacious unless it is supported by a completely balanced system of running, gating and feeding.

There is no doubt that the low yield figures and excessive amount of head metal used has been due to the lack of knowledge and scientific control in the feeding of castings. Utilising the present known theories and practices recently developed, it is quite safe to say that an average yield of 60 to 70 per cent.

* A Paper read at the 42nd annual meeting of the Institute of British Foundrymen, held in London, June 15 and 16, 1945. The Authors are respectively chief metallurgist, foundry superintendent and foundry methods engineer, K. & L. Steelfounders & Engineers, Limited, Letchworth.

The Gating and Feeding of Steel Castings

will be obtainable on general castings which are the same or superior in quality to those previously produced.

The Physics of Feeding

From time to time technical literature has described the gating and feeding of certain castings, enlightening only slightly the fundamental laws governing solidification. The most up-to-date and comprehensive data with regard to gating and feeding castings are based on applied science and were compiled by Taylor and Rominski, who based their work on the discovery made by Williams in the U.S.A.

FIG. 2.—SHRINKAGE IN A GRAVITY FEEDING HEAD.

The true value of their work lies not in the novelty of the subject, but in the systematic analysis of all aspects affecting correct gating, feeding, and solidification. The orthodox method of gating and feeding still overwhelms new ideas, but this is due to the fact that the assimilation of new theories and practices by the foundryman is a very slow process.

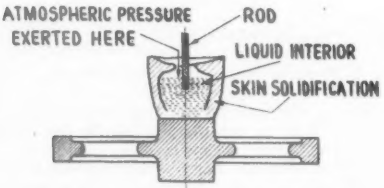

FIG. 3.—SHOWING THE OBJECT OF ROD FEEDING.

The considerable variation in the quality of a casting and quantity of scrap on the same casting in one or more foundries, using apparently the same casting method over a period of time, is an indication of how knowledge possessed can be wrongly applied. One can make a casting sound with very low yield resulting in uneconomical production. This low yield figure shows that the force of gravity was the only pressure used in obtaining efficient feeding. To increase the yield, then, additional pressure must be obtained by utilising the effective pressure of the atmosphere. Many foundrymen have failed in their efforts to use atmospheric pressure, but this is due to the fact that the theory has not been transformed into practice because certain details have been overlooked and this additional pressure has not functioned efficiently, and gravity force has been insufficient to give the necessary results.

The intelligent application of good gating and feeding is dependent on a knowledge of the science of physics. It is well known that pressure exerted at any given point on a surface of liquid exerts an equal pressure in all directions, and that the total pressure is dependent on the depth below the surface where the pressure is measured, as there will be additional gravimetrical pressure due to the height of liquid above.

FIG. 4. — SHOWING THE EFFECT OF USING FEEDING POWDER ON A HEAD.

In a system closed to the atmosphere, where the runner, riser and casting are on the same level as the

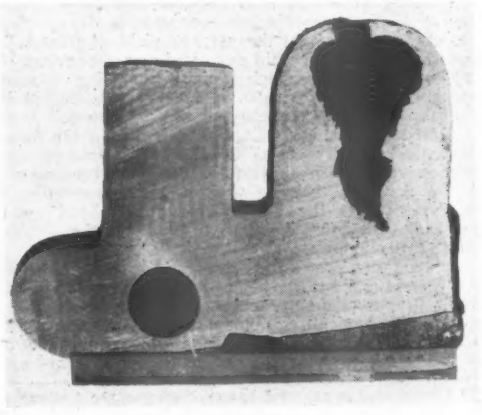

FIG. 5.—SECTION OF CASTING MADE SOUND THROUGH USING A PENCIL CORE.

top surface, the total gravimetric pressure exerted by the riser will be zero. If a flow of metal has to take place from the riser to the casting, additional force must be utilised, as, for instance, in certain cases, atmospheric pressure.

To these two fundamental laws governing gravity and atmospheric pressure, three other factors must be taken into consideration. These are:—(*a*) Volume; (*b*) temperature; and (*c*) time. For instance, with higher casting temperature, providing all other factors are constant, more feeding will be necessary, due to the lower specific gravity (greater volume per unit weight of liquid steel).

Summarising, it should be said that not one, but all, of these factors must be considered in designing the

FIG. 6.—CENTRIFUGALLY-CAST STEEL CASTING.

gating and feeding system of any one casting. At the present time, little attention is paid to any other than volume.

The feeding of castings to obtain freedom from shrinkage cavities is dependent mainly on the following factors:—

(I) Application of the most suitable pressure.
(II) The system of feeding used.
(III) The temperature gradient (*i.e.*, the promotion of directional solidification).
(IV) The speed of metal supply to the actual casting.

I—Pressure

Pressure may be applied as either:—(*a*) Ferrostatic pressure; (*b*) atmospheric pressure; or (*c*) centrifugal force.

Ia—Ferrostatic Pressure and Its Influence on Soundness

When a head relies on gravity feed alone, it must have a certain pressure to become efficient. This pressure must be obtained from head height, and, consequently, it is necessary to have a high head to supply the required ferrostatic pressure. Each inch of head height is equivalent to approximately 0.283 lb. pres-

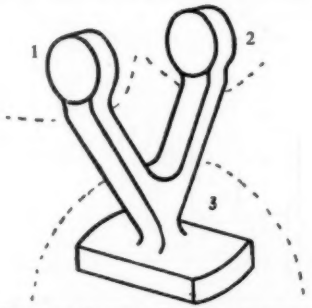

FIG. 7.—TYPE OF CASTING LENDING ITSELF TO MORE THAN ONE SYSTEM OF FEEDING.

sure (assuming 1 cub. in. steel = 0.283 lb.). As a result of this excess height, metal is wasted because its sole purpose now becomes that of providing pressure and not a supply of liquid metal to the casting below.

The feeder head should merely act as a reservoir of hot liquid metal to compensate for liquid shrink-

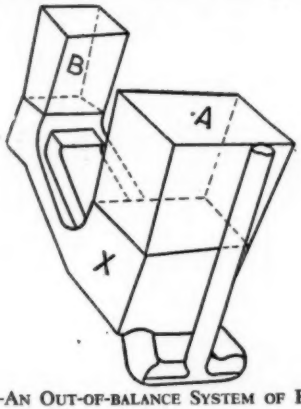

FIG. 8.—AN OUT-OF-BALANCE SYSTEM OF FEEDING.

age in the casting. If, of course, the head height is only sufficiently large to compensate for the theoretical shrinkage, one can expect considerable trouble due to lack of feed metal following upon the inevitable lateral solidification of the head itself. The head should be made considerably in excess of what is required, but the height of the head should not be increased solely

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to utilise ferrostatic pressure, if economical production is to be ensured.

Ib—Atmospheric Pressure and Its Use in Obtaining Efficient Feeding

Atmospheric pressure is equivalent to an approximate head height of 52 in. of liquid steel. Atmospheric pressure will force mercury (density 13.6) 30 in.

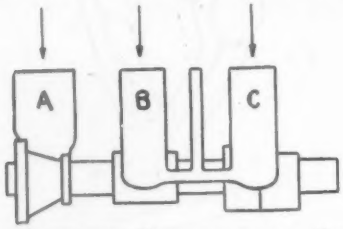

FIG. 9.—CRANKSHAFT CASTING HAVING A BALANCED SYSTEM OF BOTH GRAVITY AND WHIRLGATE HEADS.

high in a vacuum. For molten steel with a density of approximately 7.8, the corresponding height will be $h = \frac{30 \times 13.6}{7.8} = 52$ in. When this effect is harnessed to the feeding of castings, it is quite obvious that ferrostatic pressure is of secondary importance. There are many ways of introducing atmospheric pressure into a head and the general description given illustrates some of the best-known methods.

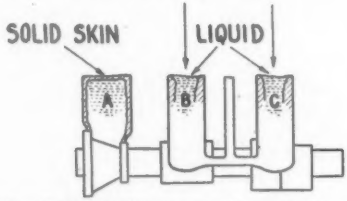

FIG. 10.—SHOWING HOW THE FEEDING SYSTEM IS UNBALANCED BECAUSE OF THE SKIN SOLIDIFICATION OF ONE HEAD.

Gravity Heads.—Normally a gravity head quickly freezes at the top surface due to rapid radiation of heat to the atmosphere. Immediately this happens, feeding depends on ferrostatic pressure only, which is equivalent to the head height. Taking the casting as shown in Fig. 1 as an example of the use of gravity heads, the following process of solidification occurs. The heads for a time remain liquid at the surface, and whilst this state exists, the time varying with the casting temperature, atmospheric pressure is exerted in the head metal and the head remains 100 per cent. efficient. Immediately the skin solidifies, the feed relies solely on gravity, and a final shrinkage in the head is obtained as shown in Fig. 2.

Rod Feeding.—The old method of rod feeding (Fig. 3) was used in the very early stages of founding, and the success of this method is acknowledged, but not really understood. It is quite clear that the efficiency of these heads that are kept open by means of a rod is due to the fact that atmospheric pressure is exerted on the still liquid metal of the head.

The Use of Feeder Powder on Heads.—The majority of commercial powders consist chiefly of a carbonaceous material with a certain percentage of the necessary Thermit mixture. The objects of this material are:—(1) The exothermic reaction caused by the Thermit mixture generates intense local heat, a certain percentage of which is absorbed by the head metal; consequently the surface of the feeder head remains liquid much longer than it would have done had no feeder powder been added. (2) The carbonaceous material goes into solution with the steel and causes a lower initial freezing temperature. These two factors alone result in the surface of the head remaining liquid for a longer period of time than if the feeder powder had not been added. (3) The least important

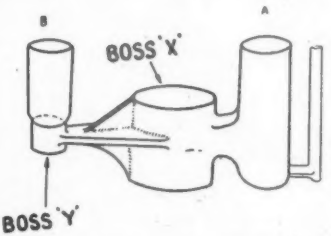

FIG. 11.—A BALANCED SYSTEM OF FEEDING A BRACKET.

function of the powder is that it insulates the head metal from the atmosphere, so preventing excessive radiation and causing the surface of the feeder head to remain fluid for a longer period.

From these three points it is clear that the success of feeder powder is due largely to the fact that an ordinary gravity head is kept open to atmospheric pressure, thus increasing the pressure by an equivalent of 50 in. of liquid steel (Fig. 4).

The Use of a Pencil Core to Aid Efficient Feeding.—In the use of blind heads, Taylor and Rominski utilised atmospheric pressure by admitting it through a small pencil core to the liquid portion of the head. To keep a gravity head open to the atmosphere, a small pencil core should be placed so that it penetrates the surface skin when it solidifies. In this way, the atmosphere is still admitted to the liquid interior and an effective pressure equivalent to a pressure of 14 lbs. per sq. in. and 50 in. of steel is still exerted. Fig. 5 illustrates a sectioned casting fed in this manner. From the head shown in this figure, three identical castings were fed and the yield obtained was 72.3 per cent.

Ic—Centrifugal Pressure

Centrifugal force is widely used to-day as a means of providing pressure for the better feeding of castings, and, apart from the effect of pressure so created, there is the added advantage of the promotion of directional solidification. The centrifugal force is caused by the revolution of the casting on its axis, or of a number of castings, around a common axis. From the revolutions per minute of the casting, the peripheral velocity can be calculated. This velocity usually depends on the size and type of castings, and normally is arranged to give a peripheral speed varying from 1,000 to 2,200 ft. per min.

The peripheral speed is one of the controlling factors of centrifugal castings, and, if too high, may cause cracks due to excessive circumferential tension, whilst, on the other hand, too low a speed tends to produce unsound castings. In the latter case, this is usually recognised by laps and entrapped oxides on the casting surface.

The best speed is between these two extremes, and it usually established by experiment. The centrifugal

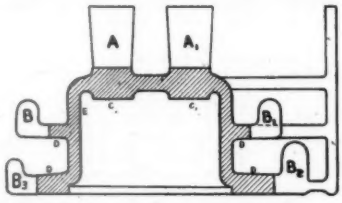

FIG. 12.—SHOWING A CASE WHERE CHILLING CAN BE USEFULLY USED.

force (F) is in normal practice equal to 75 times that of gravity, *i.e.*:—

$$F = \frac{PV^2}{gr}$$

where F – centrifugal force in lb.
P – lbs. wt. of casting.
V – velocity ft/sec.
g – gravitational force ft/sec².
r – radius in ft.

This high pressure results in a better feeding action, because high pressure forces liquid metal more readily through the light sections, and as a consequence slows down the rate of crystallisation. This is why it is possible to feed through a lighter section into heavier sections in centrifugal castings more readily than in static castings.

The advantages of centrifugal casting are:—(1) Higher yield; (2) increased soundness and cleanliness; and (3) machining allowances need not be as great as that allowed on static castings. Due to the method of running through the head, the head metal is the last to be poured. The temperature gradient is correct for the promotion of directional solidification. This is one of the reasons why castings so made are sound and have uniform properties. Freezing commences at the outside perimeter of the casting and progresses inwards. The centre portion is the last to freeze, and does so whilst the head is in the liquid state. Non-metallic inclusions and uncombined gases will find their place in the central portion, *i.e.*, in the runner head. Fig. 6 shows a typical centrifugal casting made at the Authors' foundry.

II—Systems of Feeding Steel Castings

When the method of making a casting is decided, it will sometimes be found possible to divide this casting

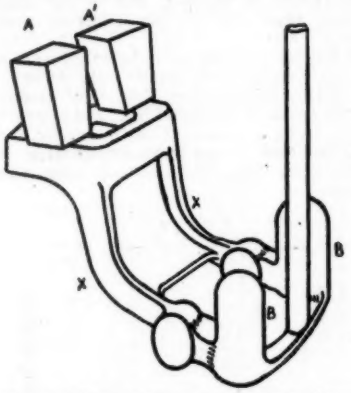

FIG. 13.—A TYPE OF CASTING LENDING ITSELF TO PRODUCTION BY THE GRAVITY AND BLIND-HEAD SYSTEM.

into more than one system of feeding. For instance, Fig. 7 illustrates the sectioning of a casting for this purpose. This indicates the heaviest sections which will require feeding.

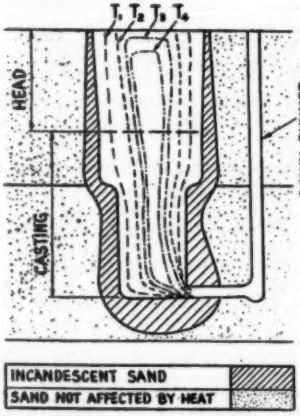

FIG. 14.—ISOTHERMS ASSOCIATED WITH BOTTOM GATING AND TOP FEEDING.

The Gating and Feeding of Steel Castings

The system of feeding chosen must be a balanced system, capable of feeding the casting. Many instances have been found where more than sufficient head metal has been supplied, yet the resulting casting has contained one or more shrinkage cavities. These shrinkage cavities have been the result of an unbalanced system of feeding, and in the majority of cases have been due to the effect of atmospheric pressure.

The following systems of unbalanced and balanced feeding are described in detail:—(1) An unbalanced (Fig. 8) and balanced system (Fig. 1) of gravity heads; (2) an unbalanced (Fig. 10) and balanced system (Fig. 11) of feeding using a combination of gravity and whirlgate heads; and (3) an unbalanced (Fig. 12) and balanced system (Fig. 13) of feeding using gravity and blind heads.

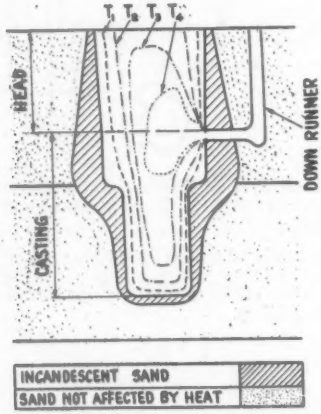

FIG. 15.—ISOTHERMS ASSOCIATED WITH TOP GATING AND TOP FEEDING.

An Unbalanced System of Feeding Using Gravity Heads

A simple illustration of this system is shown in Fig. 8. The process of casting and solidification is as follows. Hot metal is continually passing over the sand at X, losing temperature and heating up the sand, and finally coming to rest in head B. The hottest metal in this casting is located at the area X near the runner and in head A. The coldest metal surrounded by cold sand is in head B.

From the diagram it will be seen that, even due to mass effect, the surface of head B will be the first to solidify and when this effect is increased due to the points just mentioned, head B solidifies much sooner at the surface than head A. As a result of this solidification of head surfaces before the casting has solidified, atmospheric pressure becomes effective at head A, immediately head B surface has solidified, upsetting the balance of feeding. The atmospheric pressure will cause the casting to feed head B, and head A will have to compensate. Unless head A is sufficiently large to feed head B and the casting, shrinkage cavities will be found in the area X.

To balance this system of feeding, pencil cores should be used in both heads so that the atmospheric pressure remains effective in both heads even when the surface skin has solidified.

A Balanced System of Feeding Using Gravity Heads.—The casting shown in Fig. 1 can be cast safely with gravity heads because the procedure of solidification splits the casting into two separate systems. Immediately the mould is filled with metal, the web will start to solidify and will be solid much sooner than the remainder of the casting. As a result of this, head A will now feed boss Y only, and head B will feed boss Z. Atmospheric pressure will greatly increase feeding efficiency, but, should one head solidify at the surface much more quickly than the other, the atmospheric pressure still exerted at the surface of the liquid will not throw the system out of balance due to the solid web.

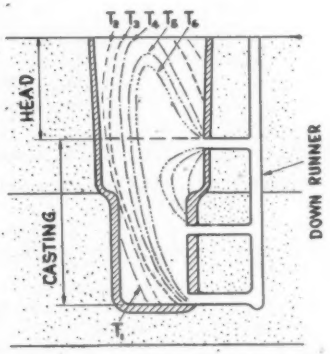

FIG. 16.—ISOTHERMS ASSOCIATED WITH STEP GATING AND TOP FEEDING.

An Unbalanced System of Feeding Using Gravity and Whirlgate Heads

The crankshaft shown in Fig. 9 utilised a combination of gravity and whirlgate heads for its manufacture. Using this method, the following procedure took place:—Metal passed down the gate into the lower parts of heads B and C, through the casting into head A. When the mould was completely filled, there was relatively cold metal at head A, surrounded by cold sand, hotter metal in the actual casting surrounded by sand which has been heated up by the flow of metal, and still hotter metal located in heads B and C surrounded by more or less incandescent sand. Even

with the use of feeder powder, head A (especially when the casting has been poured cold) begins to solidify at the surface before heads B and C. Immediately this occurs, the atmospheric pressure upsets the whole balance of the feeding system.

In Fig. 9 the system is balanced because the surfaces of the heads are still liquid, but in Fig. 10 the unbalanced effect of the atmospheric pressure is shown, because of the skin solidification of head A only. Because of the sectional thickness of the casting, the pressure at B and C becomes effective from the surface of the still liquid heads, through the casting to the surface skin of head A. In other words, the effective pressure is:—Effective pressure from heads B and C = Atmospheric pressure plus gravity at B and C less gravity at A.

From this it will be seen that immediately the surface skin solidifies, no feeding takes place at head A. In fact, the reverse occurs. Liquid shrinkage occurring in head A (*after skin solidification*) is compensated by metal from the casting, because of the pressure exerted at B and C, and, unless heads B and C are sufficiently large and efficient to feed the whole casting and head A, large shrinkage cavities will occur throughout the casting, whilst head A will be comparatively sound.

The size and extent of these cavities will be governed by the difference in time between the solidification of the surfaces of head A and those of B and C, *i.e.*, the greater the time elapsed between, the larger the cavities. Immediately the surfaces of heads B and C solidify, the feeding system becomes once more balanced, but dependent on gravity feed only. Observations have shown, however, that when this solidification of heads B and C begins at the surface, head A is almost completely solidified and, consequently, all the metal that has been used in making head A free from shrinkage cavities must be compensated by feed metal from heads B and C. Unless excessively large whirlgates are used, this will not occur, and shrinkage cavities will occur, as mentioned above.

It is obvious from this explanation that, when using a system of feeding arrangement, as shown in Fig. 9, the gravity head A is more of a liability than an asset. To maintain a balanced system of feeding in one of this kind, atmospheric pressure should be utilised in head A by inserting a pencil core. Because of the large mass of head A the heavy section of the casting will be solid before the lower portion of head A, and because the permeability of the pencil core provides the means for using atmospheric pressure at this point, a balanced system of feeding is obtained. Of course, the great drawback to this method in connection with this particular casting is the extremely low yield, and a much more satisfactory method of producing this same casting using directional solidification is shown in Fig. 19.

A Balanced System of Feeding Using a Combination of Gravity and Whirlgate Heads.—The bracket shown as Fig. 11 can be cast successfully whilst using a system of gravity and whirlgate heads. From Fig. 11, it will be seen that quite a different explanation applies to this casting from the crankshaft. When the casting has been poured, hot metal is located at head A, whilst colder metal is in head B. Solidification takes place as follows:—The first part to solidify is the thin web connecting the large and small bosses. Immediately this happens the effect of the whirlgate head is limited to boss X, whilst the gravity head B is limited to boss Y. Therefore, the casting can now be subdivided into two separate feeding systems. Now, even should the surface of head B solidify, the atmospheric pressure from head A will not be effective through the whole section of the casting, as is the case with the crankshaft. This is due to the solidification of the thin web. The boss X will be fed by means of gravity and atmospheric pressure at head A, but at the same time boss Y will be fed by means of atmospheric pressure only, whilst the surface of head B is liquid.

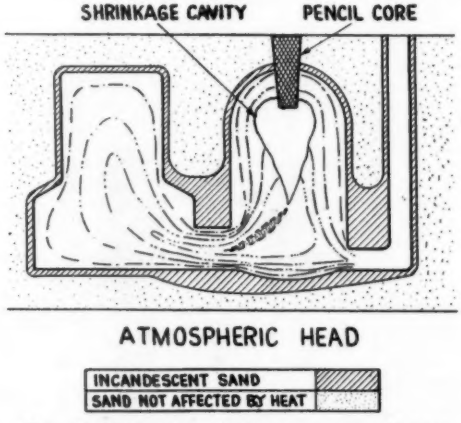

FIG. 17.—ISOTHERMS ASSOCIATED WITH GATING THROUGH A WHIRLGATE.

When this surface solidifies, boss Y is fed by means of gravity only. This is a rather unsatisfactory means of feeding, but the system is in balance because of the solidification of the thin web.

An Unbalanced System of Feeding Using a Combination of Gravity and Blind Heads

The casting shown in Fig. 12 was cast using heads A and A_1 as gravity heads to feed bosses C and C_1, and the blind heads B, B_1, B_2 and B_3 to feed bosses D. When the heads were cut off, it was found that the bosses C and C_1 were porous, but that bosses D were solid. When the heads were sectioned, it was found that the heads A and A_1 were apparently insufficiently large and that heads B, B_1, B_2 and B_3 were solid and had not fed at all.

It was obvious that heads B, B_1, B_2 and B_3 were not functioning, and it was thought that the introduction of an atmospheric core would cause these heads to work efficiently. Experiments proved, however, that

The Gating and Feeding of Steel Castings

this was not the case. The explanation of this can be found in a study of the solidification of the casting, which is as follows:—As the casting freezes, heads A and A_1, due to their mass effect, remain open to the atmosphere, and consequently the pressure exerted at

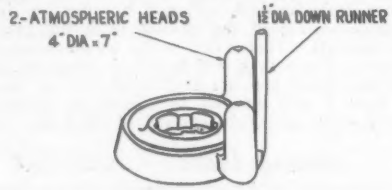

FIG. 18.

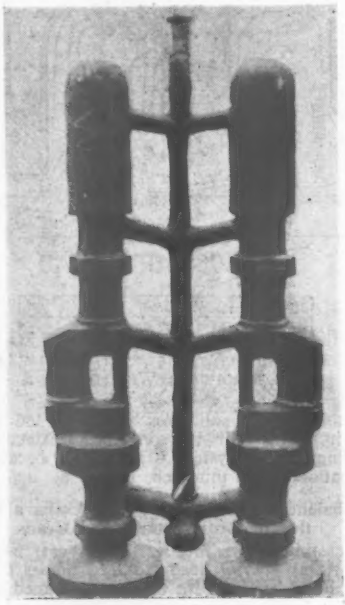

FIG. 19.

FIGS. 18 AND 19.—SHOW TWO INSTANCES OF GATING DESIGNED TO PROMOTE DIRECTIONAL SOLIDIFICATION.

A and A_1 causes the casting to feed heads B, B_1, B_2 and B_3 through the thick section at E. Even if pencil cores are inserted in the heads at B, B_1, B_2 and B_3, the atmospheric pressure on the surfaces of heads A and A_1 will neutralise the pressure obtained, and gravity force will cause the casting to feed the heads B.

The early solidification of the surface of heads A and A_1 will not improve matters, as the atmospheric pressure still exerted at B will cause the casting to feed heads A and A_1 and large shrinkage cavities will be found throughout the casting. The alternative to this system of feeding is not using heads, but chilling the bosses at D and allowing heads A and A_1 to feed the remainder of the casting.

A Balanced System of Feeding Using a Combination of Gravity and Blind Heads.—The casting shown in Fig. 13 can be cast successfully using a system of gravity and blind heads. When the casting begins to solidify, the thin webs at X are the first to solidify, and immediately the casting is split up into two systems of feeding. The first is fed by the gravity heads A and A_1, and the second by the blind heads B. Should the surface of the heads A and A_1 freeze, the atmospheric pressure exerted at B will not affect the gravity feed of these heads, because the webs at X will have solidified, and so the system remains in balance. Similar systems of balanced and unbalanced feeding can be obtained using a combination of whirlgate and blind heads and the same explanations apply to these systems as those systems of gravity and blind heads.

From these explanations, based on very simple castings, it will be seen that it is not just sufficient to supply a head or heads to a casting which are sufficient to compensate for liquid shrinkage. It is of the utmost importance that the feeding system should be balanced, and that each head should have a certain portion or portions of the casting to feed. Each head should be isolated in its effect and should not on any account interfere with the efficiency of any other head on the casting.

III—Promotion of Directional Solidification by Gating

To obtain true directional solidification, one must have in the head the hottest metal, and the coldest metal at the most distant point from the head. In addition, the insulation of the sand and its conducting properties, as well as convection currents in the liquid metal should be considered. Having all these points in mind, it is useful when gating and feeding a casting to draw attention to the various isotherms which must occur in a casting. As there are, generally speaking, four systems of gating and feeding, it may be useful to consider at this stage the occurrence of isotherms in these systems.

The four systems most commonly used are:—(1) Bottom gating and top feeding (Fig. 14); (2) top gating and top feeding (Fig. 15); (3) step gating and top feeding (Fig. 16); and (4) gating through a whirl head.

(To be continued.)

THE WAR TRANSPORT BOARD of the Indian Government has placed orders in Britain for 1,000 road rollers, at a cost of £1,500,000.

THE INDUSTRIES of the United States are being gravely hampered by the inability to obtain an adequate supply of castings. The Gray Iron Institute ascribes this bottleneck to the acute shortage of foundry labour.

A NEW METHOD OF INVESTIGATING THE BEHAVIOUR OF CHARGE MATERIAL IN AN IRON-FOUNDRY CUPOLA AND SOME RESULTS OBTAINED*

Record of results of certain tests carried out on somewhat unorthodox lines which may help to solve individual problems

By N. E. RAMBUSH and G. B. TAYLOR

(*Continued from page* 212.)

Result of Examination of Test-pieces

Figs. 12, 13 and 14 show the appearance of the steel test-pieces removed when stripping the cupola; they are numbered according to the individual charge of which they were a part and are arranged in numerical order. As already mentioned, the test-pieces placed in the first three charges had melted completely. On removal all test-pieces contained scale, ashes and adhering dirt, which were removed by wire brush before taking the photographs and sampling them for detailed examination.

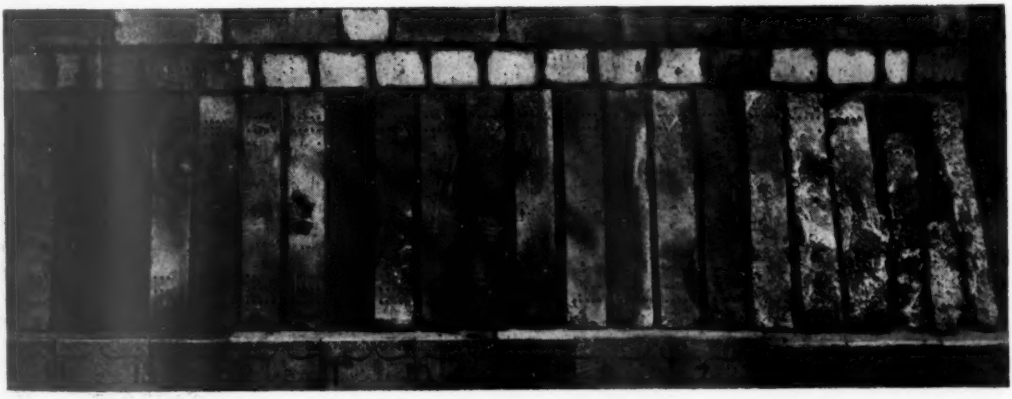

FIG. 12.—APPEARANCE OF THE TEST-PIECES AFTER REMOVAL FROM THE FURNACE.

The photographs show no definite evidence that the bars placed in the outer zone of the cupola melt more quickly than those placed in the centre zone or *vice versa*. It is also evident that the extent to which melting has occurred is not altogether in line with the depth at which the bars were found in the cupola. For example, bar No. 5 originally placed in the centre zone (and as will be seen from Fig. 2 found near the edges lower down) had apparently suffered less than bar No. 5, originally placed in the outer zone, despite the latter sample being found higher up the cupola when stripping. This fact, among others, is a practical confirmation of the belief that the intensity of heat varies considerably across any horizontal plane of the melting zone.

Fig. 12 shows all the test-pieces removed, whereas Fig. 13 shows a larger scale photograph of the seven last test-pieces (taken from the fourth to the seventh charge). These seven bars only showed actual evidence of melting. Fig. 13 indicates the way in which the melting of the steel takes place. Test-piece No. 7 (outer zone), being the bar highest up the stack to be affected, shows that fusion has commenced on the sur-

*A Paper read at the 42nd annual meeting of the Institute of British Foundrymen, held in London, June 15 and 16, 1945. The Authors are managing director and foundry manager respectively of Ashmore, Benson, Pease & Company, Limited, of Stockton-on-Tees.

Behaviour of Charge Material

face, where drops or blobs of liquid metal can be seen. As the bars descend and melting proceeds further, these blobs or drops appear to travel to the lowest part of the bar, where they collect to form one large drop, which subsequently falls from the bar and descends to the well of the furnace.

Fig. 14, which was taken from a previous test when the bar was removed from the centre about 3 ft. above the tuyere level, shows a very large drop of metal which has collected at the bottom of the bar prior to falling off into the well of the furnace. From the observations made regarding the "mechanism" of melting, the steel samples may be considered as consisting of an infinite number of extremely thin layers. As each outer layer melts, so it slides down the bar and in so doing exposes yet another layer to the influence of the reactions caused by the incandescent coke, the hot gases and the other metallic constituents of the charge. The results obtained by analysis of the bars (Tables IV and V) and from the micrographs (Figs. 15 to 22) all tend to confirm this assumption.

Chemical Analysis

Tables IV and V have been set out to show the content of total carbon and sulphur determined by analysis of all test-pieces before and after test. In an endeavour to find the mechanism of absorption of carbon and sulphur, samples of the test-pieces were taken in various ways, as follow:—

(1) Drillings taken before charging the test-pieces into the cupola.

After the test:

(2) Metal scraped from the outer surface.

(3) Drillings taken $\frac{1}{16}$ in. in from the outer surface across a transverse cut, approximately in the middle of the bar.

(4) Drillings taken from the centre of the same cross-section.

A separate investigation was made of the large metal drop which had collected at the bottom of the steel bar shown in Fig. 14. Due to its extreme hardness, this solid drop of metal had to be crushed before analysis, as it was impossible to obtain either scrapings or drillings. Due to the water quench, the bars were very hard on the outer surface, and hence accurate sampling was very difficult. For this and other reasons the analytical results obtained should not be regarded as an absolute accurate representation of the carbon and sulphur content of each test-bar as a whole, but, overlooking such inevitable differences as may exist between the analysis recorded and the average content of the part of the original bar it was taken from, it was thought reasonable to draw the following conclusions:—

(1) The carbon content in the steel test-pieces appears to increase as they travel down the cupola. This small increase in carbon content occurs regardless of whether the bars are originally placed in the outer or centre zones.

(2) After the bars have commenced to melt, the absorption of carbon increases to a much greater extent.

(3) There is little evidence that the absorption of carbon has penetrated very far from the outer layers towards the centre. Rather does it appear that as the outer surface absorbs carbon, so it melts, resulting in the formation of a large drop of metal which ultimately passes through the coke bed into the well.

TABLE IV.—*Analysis Before and After Experiment of Mild-steel Test-pieces Placed Towards the Centre of the Charge.*

Test-piece No.	Total Carbon.							Sulphur.						
	Before Test. Per cent.	After Test.						Before Test. Per cent.	After Test.					
		Scrapings.		Outside Drillings.		Centre Drillings.			Scrapings.		Outside Drillings.		Centre Drillings.	
		T.C per cent.	Difference.	T.C per cent.	Difference.	T.C per cent.	Difference.		S per cent.	Difference.	S per cent.	Difference.	S per cent.	Difference.
1	0.21	—	—	—	—	—	—	0.054	—	—	—	—	—	—
2	0.21	—	—	—	—	—	—	0.052	—	—	—	—	—	—
3	0.23	—	—	—	—	—	—	0.044	—	—	—	—	—	—
4	0.22	0.52	+0.30	0.58	+0.36	0.54	+0.32	0.043	0.150	+0.107	0.052	+0.007	0.042	−0.001
5	0.23	0.48	+0.25	0.31	+0.08	0.23	—	0.051	0.110	+0.059	0.039	−0.012	0.042	−0.009
6	0.22	0.25	+0.03	0.26	+0.04	0.23	+0.01	0.045	0.260	+0.215	0.052	+0.007	0.050	+0.005
7	0.23	0.30	+0.07	0.26	+0.03	0.23	—	0.047	0.443	+0.396	0.067	+0.020	0.046	−0.001
8	0.22	0.20	+0.02	0.24	+0.02	0.23	+0.01	0.050	0.308	+0.258	0.043	−0.007	0.045	−0.005
9	0.21	0.26	+0.05	0.27	+0.06	0.21	—	0.051	0.203	+0.152	0.052	+0.001	0.048	−0.003
10	0.22	0.21	−0.01	0.23	+0.01	0.23	+0.01	0.047	0.176	+0.129	0.056	+0.009	0.064	+0.017
11	0.23	0.22	−0.01	0.25	+0.02	0.21	−0.02	0.040	0.103	+0.054	0.054	+0.014	0.054	+0.014
12	0.22	0.23	+0.01	0.25	+0.03	0.22	—	0.046	0.130	+0.086	0.053	+0.007	0.052	+0.006
13	0.21	0.23	+0.02	0.27	+0.06	0.23	+0.02	0.050	0.123	+0.073	0.046	−0.004	0.040	−0.010
14	0.22	0.25	+0.03	0.27	+0.05	0.20	−0.02	0.047	0.083	+0.036	0.045	−0.002	0.044	−0.003

TABLE V.—*Analysis Before and After Experiment of Mild-steel Test-pieces Placed Towards the Outside of the Charge.*

Test-piece No.	Total Carbon.							Sulphur.						
	Before Test. Per cent.	After Test.						Before Test. per cent.	After Test.					
		Scrapings.		Outside Drillings.		Centre Drillings.			Scrapings.		Outside Drillings.		Centre Drillings.	
		T.C per cent.	Difference.	T.C per cent.	Difference.	T.C per cent.	Difference.		S per cent.	Difference.	S per cent.	Difference.	S per cent.	Difference.
1	0.23	—	—	—	—	—	—	0.045	—	—	—	—	—	—
2	0.22	—	—	—	—	—	—	0.054	—	—	—	—	—	—
3	0.21	—	—	—	—	—	—	0.052	—	—	—	—	—	—
4	0.22	0.85	+0.63	0.30	+0.08	0.23	+0.01	0.056	0.240	+0.184	0.057	+0.001	0.044	−0.012
5	0.23	0.30	+0.07	0.22	−0.01	0.23	—	0.047	0.130	+0.083	0.079	+0.032	0.058	+0.011
6	0.22	0.63	+0.41	0.39	+0.15	0.21	−0.01	0.046	0.230	+0.184	0.067	+0.021	0.044	−0.002
7	0.23	0.56	+0.33	0.27	+0.04	0.21	−0.02	0.045	0.250	+0.205	0.063	+0.018	0.055	+0.010
8	0.22	0.25	+0.03	0.23	+0.01	0.21	−0.01	0.044	0.421	+0.377	0.058	+0.014	0.058	+0.014
9	0.20	0.24	+0.04	0.26	+0.06	0.20	—	0.054	0.340	+0.286	0.092	+0.038	0.058	+0.004
10	0.21	0.28	+0.07	0.27	+0.06	0.22	+0.02	0.052	0.460	+0.408	0.052	—	0.047	−0.005
11	0.21	0.21	—	0.22	+0.01	0.22	+0.01	0.049	0.392	+0.343	0.054	+0.005	0.054	+0.005
12	0.22	0.23	+0.01	0.25	+0.03	0.23	—	0.049	0.400	+0.351	0.040	−0.009	0.046	−0.003
13	0.22	0.22	—	0.25	+0.03	0.20	−0.02	0.049	0.432	+0.383	0.052	+0.003	0.042	−0.007
14	0.21	0.23	+0.02	0.31	+0.10	0.22	+0.01	0.058	0.067	+0.009	0.041	−0.017	0.040	−0.018

The highest carbon content of a liquid drop (still adhering to the bar) was found to be of the order of 1.2 per cent.

(4) The sulphur pick-up by the steel test-pieces occurs very shortly after introduction, but almost entirely on the surface, the penetration inwards being practically nil.

(5) Bars placed in the outer zone of the cupola appear to be more susceptible to sulphur pick-up on the surface than bars placed in the centre zone, regardless of the height at which they were found in the shaft. Bars placed in the central zone were much less susceptible to sulphur pick-up except when found in close proximity to the top of the original coke bed.

(6) As the bars descend through the coke bed, it would appear as if some of the sulphur picked up is removed again, although not to the extent of the original sulphur content of the steel bars.

FIG. 13.—CLOSE-UP OF SEVEN BARS SHOWING INDICATIONS OF PARTIAL FUSION.

Further to elucidate the mechanism of the pick-up of carbon by the steel in process of melting, it was decided to determine the combined and free carbon in the scrapings from some of the bars, with the following result:—

Behaviour of Charge Material

	Total Carbon.	Combined Carbon.	Free Carbon.
	Per cent.	Per cent.	Per cent.
Centre No. 4 ..	0.52	0.29	0.23
„ „ 5 ..	0.48	0.32	0.16
Outside No. 4 ..	0.85	0.52	0.33
„ „ 5 ..	0.30	0.13	0.17
„ „ 6 ..	0.63	0.41	0.22

Until making this determination it had been assumed that all the carbon would be combined, but check tests from outside analysts confirmed the fact that free carbon was present in the samples analysed. The Authors do not feel competent to give a clear explanation why the carbon is not all present as combined carbon, but it is hoped that by recording the fact others will confirm the observation and possibly explain the reasons therefor.

Photomicrographs

The photomicrographs, Figs. 15 to 22, from different parts of the steel test-pieces, are shown in an endeavour to give a picture of the carbon pick-up by the steel. The size of the specimens examined was 1 in. by ¼ in. by ½ in., with the 1-in. by ¼-in. face polished and etched in each case. All pieces for examination were etched in 4 per cent. picric acid. The micrographs reproduced have been selected from among a considerable number as typical of the results we obtained. They should be studied with particular reference to Tables IV and V, which give analyses of the steel test-pieces.

In considering these photomicrographs, it should be borne in mind that the structures disclosed cannot be those normally found in ordinary mild and high-carbon steel, since the effect of the sudden chilling caused by water quenching must obviously exert a powerful influence on the structure of the steel, which at the time of quenching had attained a temperature above the critical range. The particular form in which the carbon exists is not so important, however, as the obtaining of confirmation of the extent by which the carbon has increased in the samples.

Fig. 15 shows the structure of test-piece No. 14, and indicates a normal mild-steel structure such as would be expected in the original bars. Fig. 22 represents the structure of the solid drop of metal referred to in conjunction with Fig. 14. This piece was found to contain 1.2 per cent. carbon. The structure shown consists of martensite and cementite, together with a lesser amount of troostite, and represents essentially that of a water-quenched high-carbon steel. Figs. 16 to 21 inclusive show the variation in carbon in different layers of test-pieces Nos. 4 and 6 (outer zone). Figs. 16 to 18 are of No. 6 test-pieces and Figs. 19 to 21 of No. 4. The pieces examined were taken at the following places:—Nos. 2 and 5, external edge; Nos. 3 and 6, ¼ in. inwards from the

FIG. 14.—A DROP OF METAL READY FOR DETACHMENT FROM A TEST-PIECE.

external edge; and Nos. 4 and 7, ½ in. inwards from the external edge. These micrographs show clearly that carbon is absorbed on the surface of the steel during its descent in the furnace, and that the penetration of the carbon gradually decreases from the outside edge towards the centre.

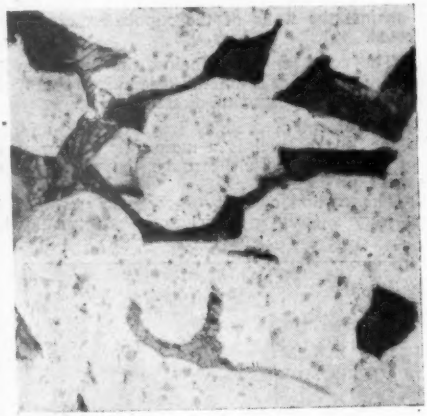

FIG. 15.—MICRO. OF 0.2 PER CENT. CARBON STEEL AND ETCHED WITH 4 PER CENT. PICRIC ACID THROUGHOUT THE SERIES.

Summary

In conclusion, the observations may be summarised as follow:—

In General:

(1) A method of water quenching a fully-charged cupola has been developed so that the normal combustion and metallurgical reactions taking place inside may be speedily and safely brought to a standstill.

(2) The method permitted observations being made at any position as to the physical state of all the metallic and coke charges.

(3) The hope is expressed that other investigators

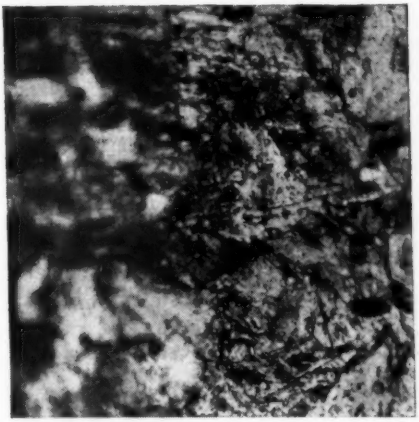

FIG. 16.—THIS AND FIGS. 17 AND 18 ARE TAKEN FROM BAR NO. 5 PLACED IN THE OUTER ZONE OF THE CUPOLA. IT CONTAINS 0.65 PER CENT. CARBON.

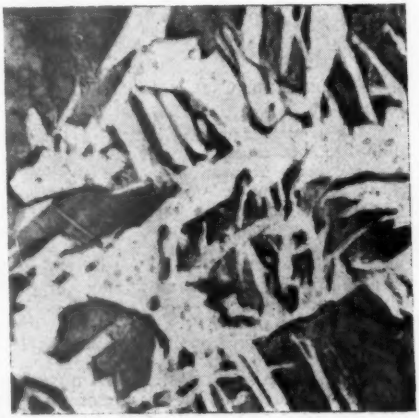

FIG. 17.—HERE THE CARBON IS 0.39 PER CENT.

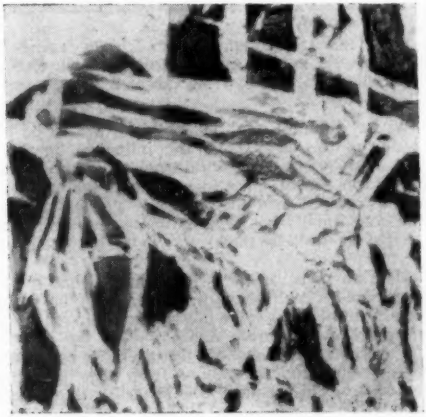

FIG. 18.—THE CARBON IS NOW 0.21 PER CENT.

Behaviour of Charge Material

may consider it worthwhile carrying out and reporting research on their own cupolas by the same method, so that the ironfoundry industry in general may benefit thereby.

In Particular:

(4) However carefully the charge materials are placed in a cupola in relation to one another, their original relative position is not maintained during the descent of the charge.

(5) The shape and size of the metallic pieces in the cupola charge are dominant factors in governing their manner of descent.

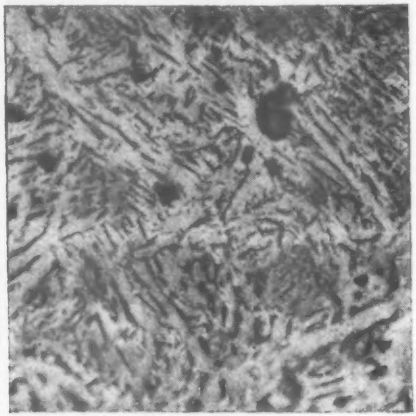

FIG. 19.—THIS AND FIGS. 20 AND 21 ARE FROM BAR NO. 4 PLACED IN THE OUTER ZONE OF THE CUPOLA. IT CARRIES 0.85 PER CENT. CARBON.

(6) Where different qualities of metal are to be produced during the day's heat, the influence on "dilution" caused by the factors referred to in the preceding paragraph are of great importance.

(7) The rate of complete melting of the different metallic constituents is mainly governed by their shape and weight as well as their relative melting temperature.

(8) Metallic constituents of the charge that require a longer time to melt than others may not be melted completely until they have descended into the coke bed to some considerable depth.

(9) The coke, although evenly sized to start with, is progressively reduced in size from top to bottom of the shaft. This remark applies to both bed and charge coke.

(10) The weight of coke contained in different heights of the cupola was found to be increased as the charge moves downwards, probably due partly to a consolidation of the coke itself and partly to the melting and softening of some of the metallic constituents of the charge at levels above the top of the coke bed.

(11) The reduction in coke size in the bed proper is not uniform across a horizontal plane, the coke found in the centre being reduced most, while the bed coke against the walls of the cupola remains almost unaffected.

(12) The coke remaining below the tuyere level is reduced most in size from the original, probably due to intermittent exposure to direct burning.

(13) The extent of the slag ledge or bridge formed above the tuyere level is a main factor altering the line of flow of materials through the cupola as the day's heat proceeds.

(14) The carbon content of the steel test-bars increases very slightly in their downward travel when solid, but on commencement of melting the carbon absorption becomes much more rapid.

FIG. 20.—HERE THE CARBON IS 0.30 PER CENT.

(15) This carbon absorption by the melting steel takes place chiefly on the surface, the centre of the steel pieces remaining practically unaltered in this respect. The highest carbon content found in a solidified metal drop was 1.2 per cent.

(16) Some of the carbon picked up by the steel remains graphitic in nature, and is not all present as combined carbon.

(17) The steel contained in the charge picks up sulphur rapidly on its surface shortly after its introduction into the cupola, but on descending some of the sulphur picked up seems to be given off again.

(18) The factors governing the erosion of the cupola lining have not been clearly elucidated, and it is considered that, until this is done in a practical manner, reliable and easy cupola control will not be obtained.

Research on different lining materials and daubing is, however, continuing.

Acknowledgments

The Authors desire to put on record their grateful thanks to Ashmore, Benson, Pease & Company, Limited, of Stockton-on-Tees, for granting the facilities which have enabled this research to be made, and for permission to publish these results; to their metallurgist, Mr. H. R. Badyal, B.Sc., for his willing and admirable help given during the tests and the succeeding investigations; and to the staff of the International Meehanite Metal Company, Limited, for the advice and guidance freely rendered at various stages of their research.

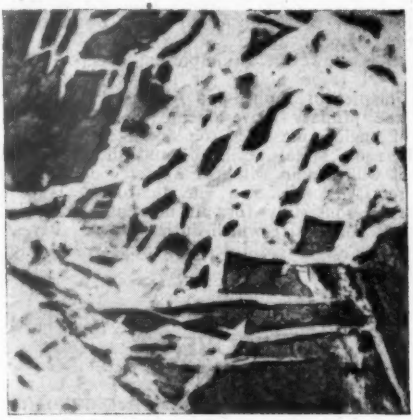

FIG. 21.—THE CARBON IN THIS CASE IS 0.23 PER CENT.

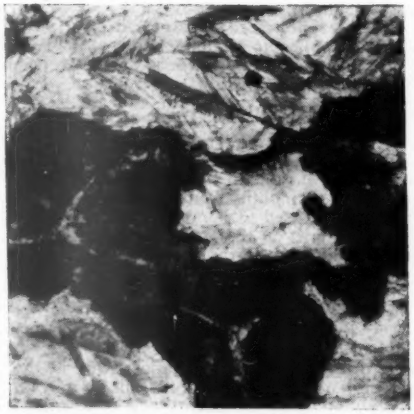

FIG. 22.—STRUCTURE OF THE METAL SHOWN IN FIG. 14. CARBON, 1.2 PER CENT.

IRON AND STEEL INSTITUTE

PROGRAMME FOR AUTUMN MEETING

The autumn general meeting of the Iron and Steel Institute will be held at the offices of the Chartered Surveyors' Institution, 12, Great George Street, London, S.W.1, on November 22 and 23. The following programme has been arranged:—

NOVEMBER 22, morning session (10.30 a.m. to 12.45 p.m.).—Official business; presentation of a Williams prize to Mr. R. W. Evans (Guest Keen Baldwins Iron & Steel Company, Limited); the following Papers will be presented and discussed:—"Distribution of Materials in the Blast Furnace—Part I," by H. L. Saunders and R. Wild; "Sinters and Sintering—Part I," by H. L. Saunders and H. J. Tress; and, if time permits, "A Rapid Method of Ore Testing: The 'S.K.' Porosity Test," by H. L. Saunders and H. J. Tress.

Afternoon session (2.30 to 5):—The following Papers will be presented and discussed: "Dolomite Linings for Basic Electric-arc Furnaces," by E. C. Brampton, H. Parnham and J. White; and "Some Design and Operating Features of a New Blooming Mill," by G. A. V. Russell and G. W. Fox.

NOVEMBER 23, morning session (10 a.m. to 12.30 p.m.).—The following Papers will be presented and discussed:—"A Micro-spectrographic Method for the Quantitative Analysis of Steel Segregates," by J. Convey and J. H. Oldfield (Paper No. 30/1045 of the Committee on the Heterogeneity of Steel Ingots (submitted by the Inclusions Sub-committee)); "Sources of Error in Diamond Pyramid Hardness Measurements on Hardened Steel," by W. N. Hindley; and "The Determination of Nitrogen in Ferro-alloys and Other Materials by Direct Nesslerisation Without Distillation," by W. C. Newell (Paper No. 29/1945 of the Committee on the Heterogeneity of Steel Ingots (submitted by the Sub-committee on Gaseous and Non-metallic Inclusions)).

I-SECTION CRANE HOOK

Prior to 1936, the best hook available at South Works, Carnegie-Illinois Steel Corporation, was forged from steel that had not been heat-treated. However, the sizes and weights of these hooks increased with rated capacities to a point where they were difficult to use, in some instances, the hooks weighing as much as 200 lbs. A satisfactory solution to the problem was found when F. H. H. Foss, of the engineering department, developed and enlarged upon an idea taken from the "I"-beam, which increases strength without increasing weight. Using the modified "I" section design, the Foss hook weighs 38 lbs. as against 120 lbs. for the conventional hook of the same lifting capacity.

COMBINED SUPPLY AND PRODUCTION DEPARTMENTS

PRIME MINISTER'S STATEMENT

Mr. Attlee, in the House of Commons, recently, made a statement on the future organisation and responsibilities of the trade, supply, and aircraft production departments.

When the present Government was formed, the Ministry of Supply and the Ministry of Aircraft Production were put under the charge of one Minister. No Ministerial appointment was made to the Ministry of Production. Under the late Government Mr. Lyttelton held the offices of President of the Board of Trade and Minister of Production. The Prime Minister's statement outlined broadly—(*a*) the organisation and responsibilities of the combined Ministries of Supply and Aircraft Production; (*b*) the disposition of the functions of the Ministry of Production; (*c*) the division of responsibilities between the Board of Trade and the Ministries of Supply and Aircraft Production.

Service Needs

For the immediate future the two Ministries of Supply and Aircraft Production will preserve their individual identities, but the intention is that they should be amalgamated into one new Ministry as soon as practicable. The primary duty of the combined Ministry will be the furnishing of supplies and the carrying out of research, design, and development for the fighting Services to the extent that these functions are undertaken by the two Ministries at the present time. This duty will be carried out in close collaboration with the Service departments in order to ensure that the "user" interests are given proper weight. The combined Ministry will, however, also be responsible for the supply (and, in many cases, the design) of a large range of stores used by the Government, for which concentration of purchasing arrangements seems advantageous, and will retain the functions hitherto exercised by the Ministry of Aircraft Production on behalf of the Ministry of Civil Aviation. The combined Ministry will carry the primary Government responsibility in the field of engineering.

The Board of Trade will remain responsible for general questions of industrial and commercial policy, and so far as these questions arise in connection with engineering, the Ministry of Supply and of Aircraft Production will work in close co-operation with the Board of Trade.

The Ministry of Production has been merged in the Board of Trade organisation and has ceased to exist as a separate entity.

Certain of the Ministry's duties were of an arbitral nature—in particular: (*a*) the allocation of materials, and (*b*) certain priorities for the allocation of labour. These functions cannot properly be performed by the Board of Trade, since that department is itself a large claimant for labour and materials, and arrangements have been made for these arbitral functions to be carried out inter-departmentally under the supervision of Ministers without departmental interest in the matter. Similarly, the co-ordination of military supply programmes is not appropriate to the Board of Trade, and other arrangements have been made for the discharge of these functions.

Raw Materials

The Raw Materials Department of the Ministry of Supply and the Raw Materials Controls of that department have been transferred to the Board of Trade as from October 29.

There is, however, an important exception to this transfer of responsibility for raw materials. Since the Ministries of Supply and Aircraft Production will carry the primary Government responsibility in the field of engineering, the Iron and Steel Control, the Non-Ferrous Metals Control, and the Light Metal Control will remain with the Ministry of Supply and of Aircraft Production. The Board of Trade will assume responsibility for all non-engineering industries (*e.g.*, chemicals), which during the war have been the concern of the Ministries of Supply and Aircraft Production.

LIMITS OF TIME FOR DEBT RECOVERY

SCOPE OF NEW ACT

By permanent law (Limitation Act, 1939) for recovery of debts, etc., to be legal, Court action must be taken within six years. This applies whether under *simple* contract (that is, ordinary contracts whether by word of mouth or written) or founded on *tort* (roughly, a tort is a matter irrespective of contract); if the case concerns a *speciality* (that is, a written contract under seal; by deed), the period is 12 years, and this period applies to actions upon a judgment. A new Act, the Limitation (Enemies and War Prisoners) Act, 1945, now lays down that, if a person who would have been a necessary party to any action if it had been brought, was an enemy or detained in enemy territory, the time when he was considered an enemy or so detained is not to count towards the limitation periods as above, and in no case shall such a period expire before 12 months from the date when the person concerned ceased to be an enemy or was detained or from the date of the passing of this Act (March 26, 1945), whichever is the later.

A point to note is that the term "enemy" does not necessarily mean an actual enemy as was, say, a German or Japanese; the term is used to cover persons who were living in occupied territory. For example, it would cover Norwegians in Norway, Dutchmen in Holland, or even British in Singapore; that is, the term includes not only enemy subjects, but people in areas under occupation by the enemy and companies carrying on business there. Prisoners of war come under the Act, but not persons engaged actively in the Services, as there were, of course, facilities for communicating by letter in most fields of war.

CENSUS OF PRODUCTION

TO PROVIDE ADDITIONAL INFORMATION

The Census of Production Committee appointed last June has published its report (Cmd. 6687, price 6d.). Its recommendations provide for the collection of additional information from industrial businesses relating to costs, fixed capital assets, stocks and work in progress, sales, and other items. The report stresses the point that in order to help the policy as set out in the White Paper on Employment the new information must be precise, so as to avoid misleading deductions; duplications by Government departments must be avoided; Government departments should use common industrial classifications; international comparisons of the census figures should be made easier; and early publication of the figures is essential.

It is recommended that the Census of Production Act should be amended to allow the collection of particulars of wages, salaries, depreciation, rent, and taxes (other than taxes on profits), and other principal items of costs. The present Act specifically prohibits the collection of particulars of wages, and this necessitated voluntary inquiries by the Ministry of Labour. The Committee considers that the amount of wages should be stated on the census schedules, together with a separate figure for salaries. In addition to depreciation, rent, rates, etc., it is recommended that advertising expenditure, a large costs item in certain industries, should be stated separately where it is important. Statistics of man-hours worked should be collected, but the Committee considers that compulsory powers for collection should be applied only after consultation with each industry and agreement with them that such statistics would be useful and significant.

The Committee considers it essential that regular and accurate statistics should be collected regarding fixed assets, stocks, and work in progress in view of the incidence of fluctuations of capital expenditure on general business and employment. The number and capacity of machines and plant installed should be collected for industries where they would be valuable for statistical purposes. This power, it is suggested, should be used only after consultation with representatives of the industries concerned.

CONSUMPTION OF NICKEL

United Kingdom consumption of virgin nickel in the first half of 1945 totalled 4,645 tons, of which 2,453 tons was absorbed in alloy-steel production, 272 tons in nickel-iron alloys, 389 in nickel-chromium alloys, 493 in malleable nickel, 310 in cupro-nickel (wrought products), 145 in nickel-silver (wrought products), 36 in non-ferrous foundries, 59 in nickel-aluminium alloys, 475 in nickel anodes and 13 tons in miscellaneous uses.

The above figures relate only to virgin nickel. The following figures give the consumption of nickel in scrap:—For alloys, steels, 5,776 tons; other uses, 1,572 tons; total, 7,348 tons.

THE PRICE OF grey-iron castings in the United States has been officially increased by 10 per cent.

FRENCH IRON AND STEEL INDUSTRY

IMPORT EXPECTATIONS

Arrivals of German coke for use in the French iron and steel industry continue to be considerably below the scheduled figure of 45,000 tons, and the deficit is being the more keenly felt following the blowing in of three more blast furnaces at Homécourt, Knutange, and Agondange respectively.

September output of pig-iron amounted to 124,000 tons, compared with 106,000 tons in August, while output of steel amounted to 168,000 tons, compared with 132,000 tons. Output of rolled products amounted to 124,000 tons, compared with 100,000 tons. Stocks of finished products, which amounted to 422,000 tons at the beginning of the year, now only total 245,000 tons, but stocks of ingots and semi-finished products increased during the same period from 421,000 to 506,000 tons.

At the end of September, 19 blast furnaces were in operation. The ore mines in the Briey basin produced 400,000 tons of ore in September, or 40 per cent. of 1938 production.

Plans for 1946 now being considered by the Government are stated to provide for the importation of more than 2 million tons of iron and steel products during the course of the year, to supplement a national output of 4 million tons. These figures do not include imports of equipment representing some one and a half million tons of iron and steel products.

STEEL PRICES AND EXPORTS

Mr. E. H. Lever, chairman of Richard Thomas & Baldwins, Limited, speaking at Swansea recently on the importance of the export trade, said that there had been a good deal of unfortunate and ill-informed criticism in regard to the question of costs in the iron and steel industry. Unfavourable comparisons had been made between the prices of British steel products and the prices of the corresponding American products. He hoped that before these criticisms were repeated the critics would remember two things—first, that in relation to the export trade it was just as important to the steel industry that its products should be as cheap as possible as it was to those that used them as the basis of further manufacture and, second, that to convert American prices into sterling at the present artificial rate of exchange, which one must do to make any comparison at all, was like taking an invalid's temperature with a thermometer which was out of adjustment.

U.K. CONSUMPTION OF TIN

United Kingdom consumption of virgin and scrap tin by main trades in the first six months of 1945 was as follows:—

Tinplate, 2,228 tons; solder, 3,198; alloys (white-metal, bronze, gunmetal, etc.), 5,936; foil and collapsible tubes, 230; tinned copper wire, 252; tin compounds and salts, 111; tinning, 282; miscellaneous uses, 304; total all trades, 12,541 tons, of which 8,016 tons was virgin tin and 4,525 tons tin in scrap.

PERSONAL

LORD RIVERDALE has left for Canada on his 73rd visit to the Dominion.

MR. HERBERT ALLISON has been appointed a director of the Weardale Lead Company, Limited.

MR. E. J. BATCHELOR, director of sales of the Darwin group, and MR. H. C. YAFFE, general manager of production, Darwins, Limited, have been appointed to the board of Andrews Toledo, Limited.

MR. IAN CAMPBELL HUMPHRIES, advertising manager of Smith & Wellstood, Limited, Bonnybridge, Stirlingshire, received a presentation from the directors and staff when he left to take up a post in Glasgow.

MR. J. W. BAILLIE, who has been secretary of Horseley Bridge & Thomas Piggott, Limited, for the past 26 years, is relinquishing that position in order to devote his full time to administering the company's affairs as joint managing director. MR. J. S. CHRISTIE has been appointed secretary as from November 1.

MR. ROBERT BOARDMAN, director and general manager, has become assistant managing director of the Furness Shipbuilding Company, Limited, Haverton Hill-on-Tees. MR. JOHN MCGOVERN retains his post as managing director. MR. JOHN H. CROSS, at present shipyard manager, becomes general manager, with a seat on the board of directors, and MR. ARTHUR BAILEY, his assistant, becomes shipyard manager.

MR. CHARLES HORRELL, who has been the chairman of Triplex Foundry, Limited, for 26 years, is retiring from the board on medical advice. His services will be available as consultant to the company. MR. H. E. HIND, who has been with the business for 24 years and who has been joint managing director with Mr. Horrell since the inception of the company in 1936, has been appointed chairman and sole managing director. MR. J. W. HORRELL, who has now returned from active service, and MR. F. H. BENNETT continue to serve on the board.

Wills

MCKINNON, C. W., of Aberdeen, retired ironfounder ...	£39,421
BECKETT, A. F., of Sheffield, steel and file manufacturer	£16,605

METALLURGICAL COURSE AT BIRMINGHAM

A proposed course in metallurgy at Birmingham University was outlined recently, when Mr. Vincent Everard entertained at dinner at the Queen's Hotel, Birmingham, Prof. D. Hanson, D.Sc., and Dr. L. Aitchison, D.Mes., B.Sc., F.R.I.C., of the University's Department of Metallurgy, and members of the Education Committee of the Council of Ironfoundry Associations. The professors explained the details of the proposed scheme to the members present, who included Mr. FitzHerbert Wright, chairman, Dr. J. E. Hurst, Capt. W. E. Hunt, Mr. J. W. Berry, Mr. R. W. Blount, Mr. J. G. Pearce, and Mr. T. E. Parkinson, secretary.

OBITUARY

MR. ROBERT J. TODD, a director of William Simons & Company, Limited, Renfrew, died recently in Glasgow. He was 79.

MR. HERBERT COULTER, of Ilkley, governing director of John France & Company (Iron & Steel), Limited, of Heckmondwike, died recently.

MR. HARMON HARGREAVES, deputy chairman of Hick Hargreaves & Company, Limited, engineers and ironfounders, Bolton, Lancs, died recently, aged 65. He was a grandson of William Hargreaves, who, just about a century ago, went into partnership with John Hick to form the company.

MR. H. S. DAVIE, general manager of Cochranes (Middlesbrough) Foundry, Limited, died last week in tragic circumstances. Mr. Davie, who was 52, was formerly at the Ormesby Ironworks, was transferred to the Stanton Ironworks, and returned to Middlesbrough to become general manager about three years ago.

MR. JAMES ASHWELL, of Walsall, died recently at the age of 77. Mr. Ashwell had a remarkable record of service with T. Gameson & Sons, Limited, malleable ironfounders, for he had been with them for over 60 years. He and his brother, Mr. Will Ashwell, rose steadily through positions of trust until both were made directors of the firm 31 years ago.

SIR GLYNN WEST has died in London at the age of 68. In the 1914-18 war he was Deputy Director-General of Munitions Supply, 1915-16, Controller of Shell Manufacture, 1916-17, Director-General of Shell Manufacture, 1917, and a member of the Munitions Council, 1917-18. A knighthood was conferred upon him in 1916. He was chairman of Sir W. G. Armstrong, Whitworth & Company, Limited, and of Armstrong Siddeley Motors, Limited, until he retired in 1926.

IN PARLIAMENT

Labour for the Foundries

CAPT. CHARLES SMITH asked the Minister of Labour whether he had examined the skilled labour position in the foundry trade and whether he was satisfied that the number of younger men within the trade was sufficient to meet future needs.

MR. ISAACS assumed that the reference was to ironfoundries, in which, he said, there was an urgent need for labour, both skilled and unskilled. He had recently arranged for a Committee on which both sides of the industry were represented, to consider abnormal methods of recruitment of men to meet the immediate problem. Another Committee was inquiring into conditions and amenities in ironfoundries. Both sides of the industry were actively engaged in considering the recruitment of new entrants.

IN THE FIGURES which we quoted in last week's leading article in connection with the production of steel castings, it should be noted that these are for the steel melted and not the finished castings.

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The High-Quality Iron for High-Duty Castings.
Made in seven standard grades or to individual requirements, this iron has a close grain structure and fine graphitic carbon content. It replaces Hematite, and tones up high phosphorus irons.
We also make Dale Refined Malleable Iron to any required specification.
STANTON
DALE Refined PIG IRON
THE STANTON IRONWORKS COMPANY LIMITED
NEAR NOTTINGHAM

NEWS IN BRIEF

MR. WINSTON CHURCHILL has accepted honorary fellowship of the Society of Engineers (Inc.).

JOHN A. SMEETON, LIMITED, engineers, merchants, etc., have removed to 116, Victoria Street, London, S.W.1.

THE LONDON OFFICE of David Brown & Sons (Huddersfield), Limited, is now at Haymont House, 3, Panton Street, Haymarket, S.W.1.

THE ADMIRALTY CENTRAL STEEL OFFICE has been transferred from Warwick to Central Exchange Buildings, 128, Grainger Street, Newcastle-upon-Tyne, 1.

"MODERN FOUNDRY PRACTICE" is the title of a lecture to be given to-morrow (Friday) by Mr. T. Arnett, foundry supervisor to Dobson & Barlow, Limited, textile engineers, etc., to the firm's supervisors and foremen.

THE FIRM OF George Todd, brass and aluminium founders, of 33, Moss Street, Paisley, has been dissolved following the retirement of Mr. John Young, one of the partners. The business will be carried on by Mr. John Graham on his own account under the existing name.

CONDITIONS IN THE FOUNDRY INDUSTRY from the point of view of health and safety were discussed on November 2 at a meeting in Glasgow of the National Union of Foundry Workers. A resolution was passed by the meeting drawing attention to the present state of legislation and pressing for an inquiry.

FOR THE SPECIAL BENEFIT of demobilised men and returned prisoners of war who are scientists, professional engineers, etc., the Ministry of Labour and National Service have asked us to invite attention to the service provided by their Appointments Department's Technical and Scientific Register at York House, Kingsway, London, W.C.2.

AN INCREASE in the national bonus and time-workers' bonus for female workers in the engineering industry has been awarded by the National Arbitration Tribunal. For women of 18 years and over the national bonus is increased by 1s. 6d. and the time-workers' bonus by 6d., with effect from the beginning of the first full pay period after September 28 last.

THE COPPER DEVELOPMENT ASSOCIATION, which during the war operated principally from a temporary office in Rugby, has now acquired premises at Kendals Hall, Radlett, Herts. All urgent communications and applications for the Association's literature should be addressed, in future, to Radlett. The Association will continue to maintain its registered address at Grand Buildings, Trafalgar Square, London, W.C.2.

MR. HERBERT MORRISON, Lord President of the Council, announced in the course of an address to the conference of Industrial Research Associations in London recently that grants to such associations are to form a permanent part of the activities of the Department of Scientific and Industrial Research. The Government would do everything possible to encourage British industry to use scientific research.

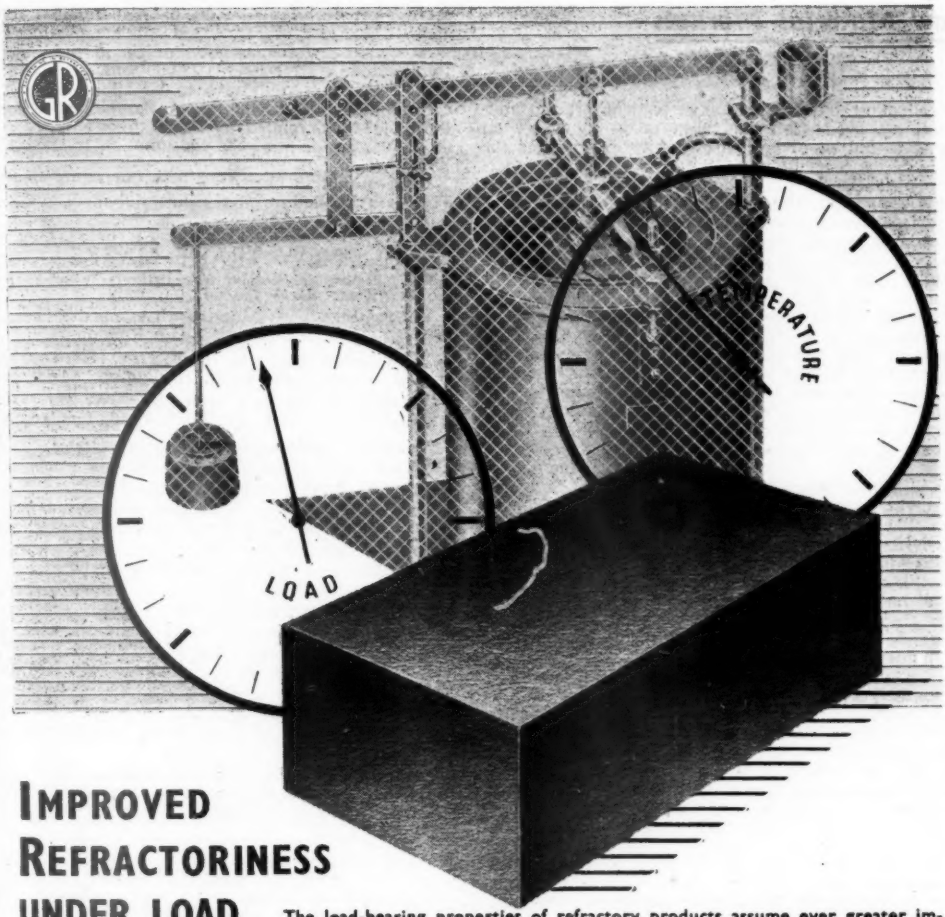
AT A SPECIAL MEETING of the No. 8 Branch of the Irish Engineering and Foundry Union, it was decided unanimously, after discussing a resolution proposed by the branch committee, that the No. 8 Branch secede from the I.E.F.U. and affiliate to an engineering branch of the Workers' Union of Ireland. This development, a branch official told our correspondent, is primarily due to a forced ballot by the executive of the I.E.F.U., which resulted in the affiliation of that union to the Congress of Irish Unions, and by the failure of that executive to call a special general meeting of the membership in order to explain the new departure from the union's major policy.

THERE HAVE BEEN FEW wartime developments in the steel tube section of the heavy engineering industry in Germany, according to Lieut.-Colonel S. M. Tate, assistant managing director of Tube Investments, Limited, who has recently returned from a tour of inspection of the Ruhr and Rhine areas. In an interview, he said: "I visited a number of German plants in 1938 and, on returning in 1945, found that little, if any, real development had taken place. On the metallurgical side, there were many signs of improvisations to meet shortage of certain materials, but the manufacturing processes themselves had not been changed, and there did not appear to be any evidence of solid metallurgical advance."

AT A MEETING of the executive committee of Forth Valley Industrial Development Council, Mr. Festus Moffat, secretary, said that intimation had been received from the Ministry of Supply that there is to be release under the group of building and ancillary industries for ironmoulders up to 1,150. It was agreed to consider this matter further when a report as to the result of this scheme is received from local ironfounders. The secretary was instructed to communicate with the National Light Castings Ironfounders' Federation on the opinion expressed that men are not readily returning to the ironmoulding trade, nor are apprentices being easily entered, by reason of the poor conditions for ironmoulders in the workshops. It was claimed by the trade union representatives that all their efforts to secure conference with the employers' representatives on this matter had met with failure. The Council agreed to invite the Federation to give early consideration to the submissions of the trade unions.

ASSOCIATED LIGHT METAL INDUSTRIES, LIMITED

Almin (Associated Light Metal Industries), Limited, has been formed with a capital of £2,000,000 to develop and extend the application of light metals and their alloys in the production of modern structural materials. Col. W. C. Devereux is managing director. Almin, Limited, controls, or is financially interested in, a number of companies, including International Alloys, Limited, Renfrew Foundries, Limited, and Warwick Aviation, Limited.



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AT HIGH TEMPERATURES

The load-bearing properties of refractory products assume ever greater importance in the design of furnace structures. This arises from the insistent demand for more efficient furnace operation and increased outputs, which entails the use of higher temperatures and heavier loads. General Refractories' products keep abreast of all requirements by the operation of a system of strictly controlled processing in which importance is placed upon raw material selection, grading and high temperature firing. Widely used throughout the country and overseas, G.R. products provide a complete answer to the vital need for strong, stable, and lasting furnace linings.

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Raw Material Markets

IRON AND STEEL

Production and distribution of pig-iron are on familiar lines. Good care has been taken to ensure an aggregate output of basic iron which suffices for the needs of the steel furnaces, many of which are operating on mixtures of which more than 50 per cent. comprises scrap. The foundries, too, are getting sufficient iron to meet their immediate needs, but they have only slender reserves and, with more skilled labour available, the provision of ampler supplies of foundry iron would at once become a matter of urgency. The authorities must be well aware that more iron will be needed if all the castings are to be provided for the prospective housing programme, and it will be their duty to provide the raw materials, the fuel and the labour which are required to increase pig-iron production. The engineering foundries are now replacing cancelled war contracts and a better demand has developed for refined and low- and medium-phosphorus iron.

All classes of semi-finished steel, including defectives, are in constant demand, and if nobody is carrying stocks of any great magnitude, none has yet run so short that re-rolling operations have been interrupted. This is a satisfactory achievement in view of the heavy increase in the consumption of sheet bars, billets, etc., but with demand still rising, the position has become precarious and the need for the import of further tonnages from abroad is clearly envisaged.

The flow of specifications for plates—particularly the lighter sizes—from the shipyards is quickening. But the mills are not so dependent upon the shipbuilding industry for the maintenance of full-scale activity. Various other industries are using bigger tonnages and, with substantial export business also in hand, the plate mills have attractive rolling programmes. The rail and light-section mills are quite as favourably placed, though there is still scope for the acceptance of orders for heavy joists, channels, etc.

Wire mills also have a big volume of orders in hand, and if the sheet trade is quieter, it is merely because order-books are so congested that producers are as reluctant to enter into further commitments as buyers are to place orders with only the haziest idea of when they can count on deliveries coming to hand.

A Ministry of Supply Order, which came into force on November 12, increases the price of mild drawn mild steel wire, annealed mild steel wire, galvanised barbed wire, wire netting, wire chain link fencing, and wire rod and wire rod reinforcement mesh.

NON-FERROUS METALS

Copper consumption in this country has not shown any substantial increase of late. Figures for 1944 show the total consumption of virgin metal as 348,139 tons. This year the figure is 278,725 tons for the first three quarters. It is estimated that output of copper from Northern Rhodesia during 1944 totalled 200,000 tons—a decrease of 51,000 tons on the previous year.

The estimated consumption of tin in the American tinplate industry for 1945 is 28,000 tons. It is expected that 29,000 tons will have to be allocated for 1946. Consumption of virgin tin in the United Kingdom during 1944 amounted to 18,435 tons. For the first three-quarters of this year consumption totalled 11,975 tons.

Lead output in Canada is reported to be declining. This is attributed to the serious labour shortage.

NEW TRADE MARKS

The following applications to register trade marks appear in the "Trade Marks Journal":—

"MORGANITE" — MORGAN CRUCIBLE COMPANY, LIMITED, Battersea Church Road, London, S.W.11.

"TEX"—Die castings. MAGNATEX, LIMITED, Harlington Works, Bath Road, Harlington, Middlesex.

"MARLCO"—Machine tools, etc. W. H. MARLEY & COMPANY, LIMITED, 105, High Road, London, N.11.

"HARMET"—Electrodes for use in welding. PADLEY & VENABLES, LIMITED, Dominion Steel & Tool Works, Hill Street, Sheffield, 2.

"M.G. 1, 2 & 3" — Aluminium-magnesium alloys. JAMES BOOTH & COMPANY, LIMITED, Argyle Street Works, Nechells, Birmingham, 7.

"KAMITE" — Foundry moulding powder. Jos. PROKOP & COMPANY, LIMITED, Coventry House, 3, South Place, Moorgate, London, E.C.2.

"HERMDEL"—Unwrought and partly wrought common metals. F. J. DELVES & W. HERMSEN, c/o W. P. Thompson & Company, 12, Church Street, Liverpool.

"FOSECO"—Coke forks, corundum and emery wheels, moulding and stamping tools, etc. FOUNDRY SERVICES, LIMITED, 285, Long Acre, Nechells, Birmingham.

"FLEET-FOOT"—Power-driven cranes and loading apparatus. JAEGER MACHINE COMPANY, c/o Frank B. Dehn & Company, Kingsway House, 103, Kingsway, London, W.C.2.

NEW COMPANIES

("Limited" is understood. Figures indicate capital Names are of directors unless otherwise stated. Information compiled by Jordan & Sons, 116, Chancery Lane, London, W.C.2.)

Manifold Machinery Company, 21, Hermitage Road, Birmingham—£5,000. C. C. Poole.

Renfrew Foundries, Vernon House, Sicilian Avenue, Bloomsbury Square, London, W.C.1—£100.

Quincey Engineering, 509, Green Lanes, Harringay, London, N.4—£1,000. O. H. S. and E. E. Quincey.

Engineers Supplies (Nottingham)—£3,000. B. T. Culley and R. G. Lee, 2, Ridsdale Road, Nottingham.

W. L. Foster, 39, Victoria Street, London, S.W.—Engineers, etc. £1,000. W. L. Foster and L. N. Shorter.